extreme exactitude of cranial measurements, especially when based, for example, on the cephalic index only, has often led to creating imaginary races among a given people.

These and other wholesome warnings are uttered by O. Hovorka Edler von Zderas in the *Centralblatt für Anthropologie*, iii. p. 289, who also points out that there is no need to calculate indices to the first or second decimal, and he also states that in the analysis of a people one should not take account of differences of less than ten units in the index.

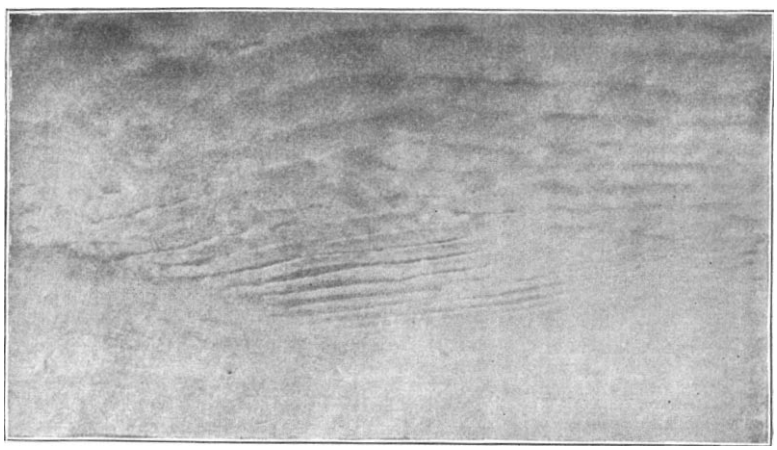
As all investigators are well aware, the cephalic index gives no information upon the real form of the skull; this has been well emphasised by Sergi, who has sought to establish a more rational system of skull nomenclature. M. L. Laloy supports (*l'Anthropologie*, x. p. 105) Hovorka's general contention, and refers to the clever visual analysis of the inhabitants of Bretagne by Dr. P. Topinard, which was published in the *Journal of the Anthropological Institute* (1897, xxviii. p. 99). In the last number of the *Journal* (new series, i. p. 329) Dr. Topinard gives the results of the trip which he made to Cornwall last year in order to compare the anthropological types there with those he had previously ascertained in Bretagne. But in our own country Dr. J. Beddoe has long adopted a similar method of investigation, and his acute and trained powers of observation have thrown a flood of light on the problems of the races of Britain. The methods of the *doyen* of British anthropologists are those of the field naturalist, and there are many who realise that what is generally known as "natural history," is as integral a part of biology as is the most refined laboratory technique. It is well to use one's eyes for other purposes than for reading off scales on instruments.

## *WAVE OR BILLOW CLOUDS.*

A SERIES of cloud photographs taken by Mr. Alfred J. Henry, of the United States Weather Bureau, and contributed to the *Monthly Weather Review* for February, is on several grounds specially instructive. It is too frequently the case that photographers content themselves with a single plate of a cloudy sky, which specially recommends itself to their notice by the grouping and arrangement of the vaporous patches. But in this instance we have a succession of pictures of the same clouds, showing their variation during the interval, and, moreover, taken in various azimuths at different stations, so that we get the same formation viewed from different standpoints. We regret that we can only reproduce one of the very admirable pictures that Prof. Henry has secured, It is the first of the series, and shows the typical arrangement of these clouds as they first arrested the attention of the observer. The altitude was probably that of the mean altocumulus level. Occurring as these clouds do at all possible heights above the surface, we are glad to notice that the term wave or billow, following the nomenclature of Helmholtz, is coming into use, since such a description more nearly expresses the character of the formation than do other terms which generally refer to the height alone.

We have here in the cause of the formation of these clouds an instance of the advantage of theoretical investigation over simple observation. The readings of meteorological instruments explain nothing of the origin or behaviour of atmospheric waves. Prof. Henry has recorded for us, with the care that becomes a meteorologist, that the wind was blowing steadily from the north-west with a velocity of twelve miles an hour. Rain had ceased shortly before, and the temperature, which had fallen to 34° during the night, had risen at the time at which the photograph was taken (8h. 25m. a.m.) to 36°. The direction of the parallel bands when first observed was approximately east and west. Later they took up a position about N. 80° W. to S. 80° E. In an hour and a half the typical appearance of the billow wave had passed away, leaving the sky about half covered with cirrus and cirro stratus. It is not unimportant to note, however, that the occurrence of similar weather conditions gave rise to a similar formation of clouds (also photographed) some two months later.

This is all that instrumental registration and careful observation can teach us, and possibly the slow onward movement of meteorological science is traceable to the strict adherence we have generally shown to the record of instrumental indications, rather than a confident appeal to theoretical research. But the study of such a cloud formation as that pictured here goes a step beyond the reading of instruments, and places in our hands a powerful means by which to investigate the motion of the atmosphere. It cannot have escaped general notice that this regular arrangement of streaks presents the peculiarity of covering a considerable extent of the sky, almost simultaneously. On a comparatively clear sky these strips of cloud are suddenly formed; and on the other hand, a sky uniformly covered can, in a very short space of time, break up and offer the appearance of these billow waves. This sudden origin of parallel streaks finds a complete analogy in the formation of waves over still water, when a slight wind agitates the surface, and it is seen to break into ripples over a considerable area. Von Helmholtz, working on this suggestion, has shown conclusively that these billow waves are due to the existence of air strata of different temperatures moving with different velocities, and are produced at the surfaces of separation of these various strata. Travellers in balloons have confirmed this theory from actual experiment, and have shown that at very various altitudes this peculiar formation is encountered. It may be that the billow clouds are visible to us only under peculiar circumstances of moisture, but the wave motion in the invisible air is probably a most common phenomenon, and one that plays a large part in determining our weather conditions.



Wave or Billow Clouds.

## *THE PROPOSED MAGNETIC SURVEY OF THE UNITED STATES.*[1]

THE present superintendent of the Coast and Geodetic Survey, Prof. Henry S. Pritchett, perceiving the need of expansion in the magnetic work of the Survey, has brought about the formation of a separate division, known as the Division of Terrestrial Magnetism of the United States Coast and Geodetic Survey. The chief of this division is to be Dr. L. A. Bauer, who will have full control of all magnetic work, both in the field and in the office.

The following preliminary outline will serve to give some indication of the character and scope of the work it is proposed to carry out with the enlarged opportunities.

### SECULAR VARIATION INVESTIGATIONS.

The best evidence of the great demand for secular variation data is the fact that, thus far, eight editions of Schott's secular variation paper have been successively issued by the Survey.

[1] Abridged from an advance proof of a paper by Dr. L. A. Bauer in *Terrestrial Magnetism*.

In all matters relating to the re-location of land boundaries, where it is frequently necessary to know the precise amount of angular change in the direction of the magnetic meridian since the first or original survey, the Coast and Geodetic Survey is recognised throughout the country as the ultimate authority. The amount of money saved to landowners by such authoritative determinations as the Survey is able to furnish, can scarcely be estimated. It certainly exceeds many times the total amount to be spent for magnetic work.

Every effort will be made in the future to multiply and verify the secular variation data, and requests for information on the part of surveyors will be encouraged in every possible manner and true meridian lines established for them.

This involves the determination of the magnetic elements, declination, dip, and intensity at various points throughout the land. Exactly how close the stations shall be to each other depends upon the special purpose to be accomplished with the means at hand, and the magnetic character of the regions involved.

A magnetic survey has peculiar difficulties to contend with; for the quantities to be experimentally determined are for ever undergoing changes—some periodic, others not periodic. A magnetic survey must, therefore, be made to refer to some particular moment of time, and such means must be taken as to enable one to reduce all the measurements, not only to the selected epoch of the survey, but also, as occasion may demand, to some other epoch in the near past or in the near future. Means must also be taken for the proper elimination of all such errors as are to be referred entirely to the particular magnetic instrument used, *i.e.* instrumental errors.

### Number and Distribution of Stations.

At how many stations it will be necessary to determine the magnetic elements? The areas of the countries at present belonging to the United States are, approximately, as follows :—

| | | |
|---|---|---|
| United States ... ... ... | 3,025,600 | square miles |
| Alaska ... ... ... ... | 577,390 | ,, |
| Hawaiian Islands ... ... ... | 6,250 | ,, |
| Porto Rico ... ... ... ... | 3,530 | ,, |
| Total ... ... ... | 3,612,770 | ,, |

Hence the area is equal to that of entire Europe, or about one-fifteenth of the entire land area of the globe. As magnetic surveys have been especially prosecuted in Europe, it will be of interest to note the density of distribution of the magnetic stations in two recent, fruitful magnetic surveys—viz. that of Great Britain, where there was one station to every 139 square miles; and that of Holland, embracing one station to every 40 square miles.

Suppose one station is decided upon, on the average, to every 100 square miles—an end that may be obtained some day—then the determination of the magnetic elements would be required at 30,000 stations within the United States. At the rate of 400 stations a year, the magnetic survey, as detailed as this, would require for its completion at least seventy-five years. It is not well, however, to have a magnetic survey extend over such a long interval of years. The errors incurred in reducing the observations to a common epoch would greatly exceed the errors of observation.

It is evident, then, that a very large number of observers and instruments would be required to complete the survey within a short interval, say ten years at the most, or a less detailed survey will have to be undertaken.

The plan of conducting a magnetic survey of the United States which appears to be best suited to the present conditions, and one that it is possible to carry out within a reasonably short time, is as follows :—To make first a general magnetic survey of the country with stations about twenty-five to thirty miles apart; then, as opportunities present themselves, to add stations in the magnetically disturbed areas. The observations at the "repeat stations," made from time to time, will furnish the proper secular variation corrections.

The great advantages of this plan over that of attempting a greatly detailed magnetic survey at once, the steady progress of which over the entire country, on account of its extent, would necessarily be very slow, will be readily perceived. It will be of interest, however, to point out that the plan, as briefly outlined, will make it possible, within a reasonable time, to construct two sets of magnetic maps for the same epoch, each set based upon a different distribution of the stations. An opportunity will thus be afforded, as in the case of the magnetic survey of Great Britain, to obtain some idea of the accuracy with which the isomagnetic lines can be determined. The satisfactory solution of this question will serve as a valuable guide in future magnetic work.

Various State geologists, incited by the example set by the State Geologist of Maryland, Prof. William Bullock Clark, either have already made plans, or are making plans, for detailed magnetic surveys of their respective States, in co-operation with the Coast and Geodetic Survey.

### Magnetic Survey of Ocean Areas.

Provision for the determination of the magnetic elements at sea are being made. With the many vessels at the service of the Coast and Geodetic Survey, exceptional facilities for this purpose will be afforded. In fact, one of the chief duties of the Survey is the supplying of magnetic data to the mariner. From an economic standpoint this feature of magnetic work is the one really of the greatest practical importance. In recognition of this fact, the Survey vessels will hereafter take advantage of every opportunity to obtain the magnetic elements on sea and on shore.

### Magnetic Observatories.

The rapid, successful, and economical execution of the plans as above briefly outlined requires the establishment, at certain points, of magnetic observatories, where the countless variations in the earth's magnetic force are continuously and automatically recorded, enabling thus the proper corrections to be applied to observations made at stations at any hour of the day.

The present plans contemplate the establishment of a magnetic observatory near Washington City—this will be the Central or Standard Observatory; another near Seattle, State of Washington; one in the Hawaiian Islands, and one in Alaska. With the co-operation of the observatories at Toronto, Mexico and Havana, and with the aid of secondary or temporary observatories established as occasion may demand, the areas to be surveyed will be fairly well covered.

It is very much to be hoped, however, that the universities and colleges in the United States will seriously consider the establishment of magnetic observatories. Many an institution which lacks the means of making a reputation in astronomical work, could still afford to inaugurate useful work in terrestrial magnetism.

The United States stands at the bottom of the list of civilised countries possessing magnetic observatories. Almost every European Power of note maintains, not only one, but several permanent magnetic observatories. France has four already established, and four additional ones in process of erection; and progressive Japan, with its small strip of territory, has six continuously operating magnetic observatories.

The recent International Magnetic Conference recommended the establishment of a magnetic observatory at the Lick Observatory. It is earnestly to be hoped that this suggestion will be carried out. It is unfortunate that the San Antonio observatory in Texas had to be abandoned. A permanent observatory should be re-established in this locality.

The scheme of work for the Coast and Geodetic Survey observatories will embrace, in addition to the regular magnetic work, observations in atmospheric electricity and of the electric currents within the earth. Such observations can be carried on with practically no additional cost, and yet add greatly to the value of the observatory work. Arrangements will likewise be entered into with the Potsdam Magnetic Observatory for the making of strictly simultaneous observations of a special character.

The plan of referring the initiation and prosecution of magnetic work in America to such a well-organised department as the Coast and Geodetic Survey, the work of which is recognised universally as of the highest order, will readily be seen to have decided advantages. In the first place, the machinery for carrying on the work is already to a great extent in existence. The observer engaged in geodetic or astronomical work can frequently include to advantage magnetic observations, and thus can often be saved the chief cost of magnetic work—the occupying of stations. Again, the care and refinement with which the geodetic and astronomical work of this bureau is carried out will ever be an incentive to keep the magnetic work of the same high order.